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VACUUM SEAL FOR SHAFT
[VAKUUMNOYE UPLOTNENIYE VALA]

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VACUUM SEAL FOR SHAFT*

This invention pertains to vacuum technology and may be used specifically in installations for conduct of physics research, in vacuum metallurgy, and other ultra-high vacuum installations in which rotary-oscillatory movement of objects is needed in conditions of an ultra-high vacuum.

Vacuum seals for a spherical surface in the form of rubber sleeves are known [1].

These seals cannot be used in ultra-high vacuum installations, however, because of their low temperature resistance and high level of gas release.

A vacuum seal for a shaft is known, which consists of a vat placed in a housing with an inner wall and liquid seal as well as a separator shell that is hermetically connected to the shaft and a pre-evacuation chamber [2].

The known seal does not support sealing during oscillatory movements of the shaft, however.

The object of the invention is to ensure sealing of a shaft that performs rotary-oscillatory movements.

The stated objective is achieved by the fact that, in the known seal, the inner wall of the cell is made as a spherical membrane affixed to the base of the vat, the latter is connected

* Numbers in margin refer to pagination in original document.

to the shaft by means of a ball hinge, the pre-evacuation chamber is formed by the base of the vat and an elastic membrane, which is placed between the housing and shaft while the separator shell is made as a hemisphere.

In addition, the ball hinge is formed by a liner with its outside spherical surface connected to the separator shell by means of a thin-walled tube. The membrane is connected to the shaft by means of the sleeve seal and is made reinforced.

The high-vacuum seal of the shaft is shown in the drawing.

The seal contains a vat 2 mounted in a housing 1 with a liquid seal 3. A fusible metal (lead, indium) or a eutectic alloy of them can be used as the seal. In order to reduce the

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scale of the seal, the vat 2 is equipped with a spherical membrane 4. The separator shell 6, made as a hemisphere, and a ball hinge 7 mounted in a tapered recess *a*, which is made in the wall of the vat 2, is hermetically secured to the shaft 5. The cylindrical portion *b* of the ball hinge 7, which consists of a thin-walled tube, is used as a heat bridge to reduce the heat flow to the shaft 5. Fixation of the ball hinge 7 is accomplished by means of the elastic elements 8 and a conical bushing 9 with a spherical recess *b*. To improve the seal's conditions of operation and enhance its reliability, grooves filled with small beads 10 are made on surfaces *a* and *b*. In its lower

portion, the shaft 5 is sealed with a forevacuum seal 11 with a bearing 12. The seal 11 is hermetically connected to the housing 1 by means of an elastic reinforced membrane 13, for which the lower wall of the pre-evacuation chamber is used.

A heater 14 is used to produce the liquid phase of the seal 3. Fixation of the vat 2 to the working space of the high-vacuum installation (not shown in the drawing) is accomplished by means of a flange [15].

The seal operates as follows.

The fusible seal 3 is poured into vat 2 before starting use of the seal. The vat 2 and separator shell 6 must be tinned or coated with a metal, which is a readily wettable seal, in order to ensure the tightness of the wall.

The connector flange 15 is then hermetically connected to the working space of the installation (not shown in the drawing) and evacuation of the working chamber of the installation and the pre-evacuation chamber of the seal is carried out. After this, the seal is ready for operation. To transmit the type of movement needed, the shaft 5 will either rotate or oscillate. Simultaneous rotary and oscillatory movement of the shaft 5 is possible. With oscillatory movement of the shaft, the separator shell 6 will enter the vat 2, which is confined on one side by a cylindrical wall, and by a spherical membrane 4 on the other. As this occurs, the ball hinge 7 will rotate and perform

oscillatory movements along the beads 10. The seal operates with continuous evacuation of the inner cavity of the seal by means of an initial vacuum pump (not shown in the drawing). The membrane 13 ensures the possibility of oscillatory movement of the shaft 5.

The proposed seal may be used in installations with a pressure of up to $5 \cdot 10^{-13}$ mm Hg or less. The seal has a high degree of hermeticity characterized by leakage factor that is less than the boundary of maximum sensitivity of modern mass-spectrometric leak-detection equipment.

In addition, the seal has a low magnitude of gas release (10^{-10}L·mm Hg) and in-leakage ($5 \cdot 10^{-12}$L·mm Hg/sec), a high level of reliability, the ability to transmit major torque moments, a long operational life (10,000 hours), and the ability to perform oscillatory-rotary motions of the shaft within the working space of the chamber with absolute precision of the transmitted movements thanks to the rigid connection.

Claims of the invention

1. The vacuum seal of the shaft, which contains a vat with an inner wall and rigid seal mounted in a housing as well as a separator shell and pre-evacuation chamber hermetically connected to the shaft *is distinguished by the fact* that, for the purpose of ensuring hermetic sealing of the shaft, which performs rotary-oscillatory movement, the inner wall of the vat

is made in the form of a spherical membrane affixed to the base of the vat, the latter is connected to the shaft by means of a ball hinge, the pre-evacuation chamber is formed by the base of the vat and an elastic membrane placed between the housing and shaft while the separator shell is made as a hemisphere.

2. The seal described in paragraph 1 *is distinguished by the fact* that the ball hinge is formed by an insert with an outer spherical surface, which is connected to the separator shell by a thin-walled tube.

3. The seal described in paragraphs 1 and 2 *is distinguished by the fact* that the membrane is connected to the shaft by a sleeve seal.

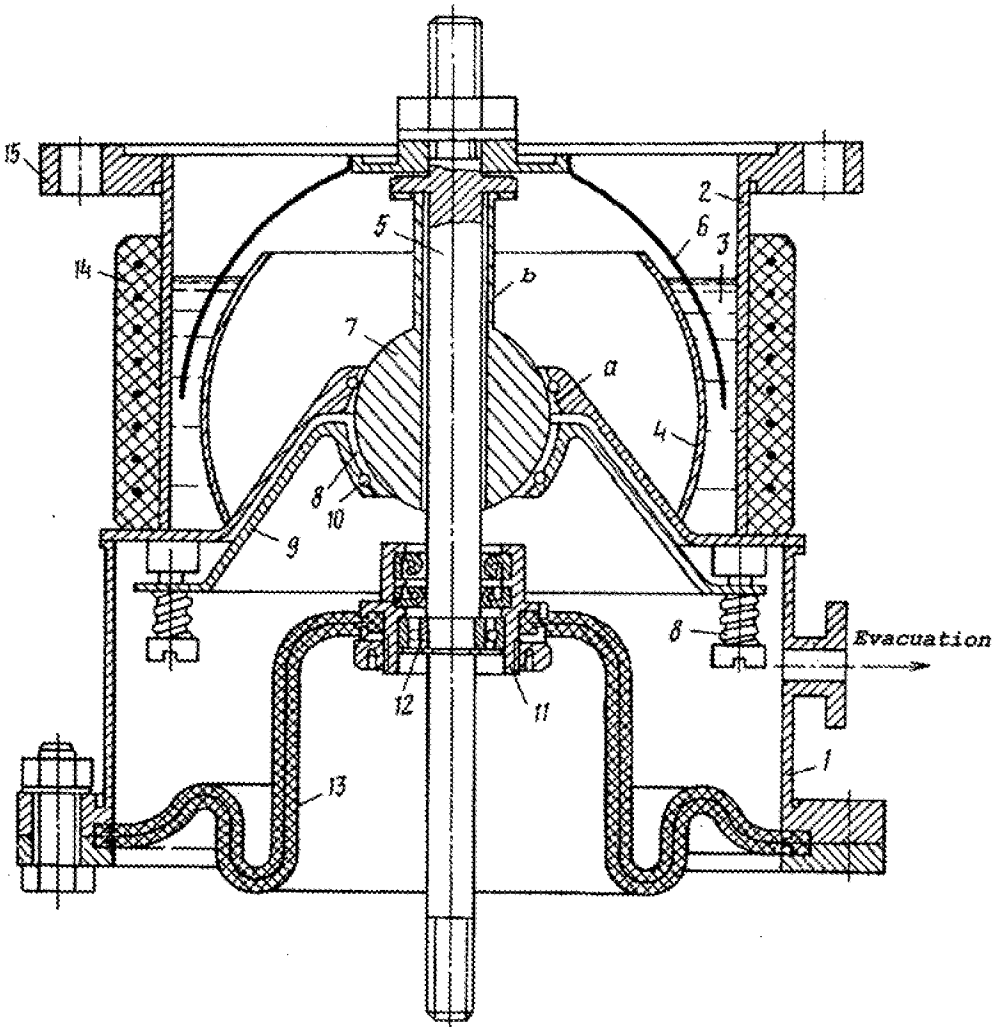
4. The seal described in paragraphs 1 - 3 *is distinguished by the fact* that the membrane is reinforced.

Information sources

brought to attention during expert review

1. Danilin B.S., Osnovy konstruirovaniya vakuumnykh system [Foundations for the Design of Vacuum Systems], Moscow, Energiya, 1971, pp. 225 - 225.

2. USSR Patent № 177715, Claims F 15 J 15/52, 1963 (prototype).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